TWO NEW TERMS CORMOPHYTASTER AND XENIOPHYTE AXIOMATICALLY FUNDAMENTAL IN BOTANY

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A generation ago botany possessed in the popular mind the unenviable reputation of being a dictionary study because of the rather large vocabulary necessitated by precise organography, though its terms were mostly self-evident to one possessing knowledge of the proper or current meaning of Latin roots. The specialization in biology that the last quarter-century has brought about has revealed so many new facts and ideas calling for equal precision that its burden of verbiage has grown inordinately, largely through the coining of Greek derivatives from roots not always used with apt differential meaning, *e. g.*, many words, of which I shall use several monotonously, in which the omnipresent "phyte" and "sperm" appear. This has grown, sometimes quite unnecessarily, to such a degree that a general biologist is likely to be puzzled by the language of a general treatise on either botany or zoology, while current publications on the newer branches of botany may be all but meaningless to a person familiar with the science at large,—sometimes, it must be confessed, when the essential ideas might have been conveyed in language intelligible to people of unspecialized training, and entirely free from technicalities.

Though I share the popular horror of pedantry or unnecessary technicality in expression, and would reduce rather than increase the vocabulary of specialization, it should not be understood that I fail to see that new knowledge and thought call for new expression, quite as much as new and varied tools became necessary as the rough construction of the stone age passed into the refined shaping of wood and metal that characterizes the age of steel; and the purpose

of the present communication is to propose the addition of two more to the words of precision of our day. Both of the new terms may be dispensed with, it is true, as they have been thus far, if one be disposed to paraphrase sufficiently, or to avoid reference to the well-known facts that they express; but these facts are so fundamental to a correct understanding of plant morphology that the latter course can scarcely be looked on as desirable, while the former—as every thinking teacher of the science has discovered—proves far from easy. One of them refers to the one-time division of the Vegetable Kingdom into Thallophytes and Cormophytes, now a question of morphology rather than of taxonomy; the other, also morphological, to the entities that compose the life cycle of one of the highest plants, whose alternating generations are usually spoken of as sporophyte and gametophyte (or the non-sexual and the sexual generation).

It is understood in a sense that the characters of genus, family and higher taxonomic groups are to be read into the characters of every species; but even novices know that this can be done only by reading into these group characters a number, sometimes large, of aberrations and exceptions; so that the popular idea of a thallophyte, with the body undifferentiated into stem and foliage, is not shaken by the occurrence of very stem-and-leaf-like algæ, any more than the popular idea of a cormophyte, with regularly disposed foliage on a supporting axis, is disturbed by seeing that a vegetating *Wolffia* possesses the simplest thallus configuration, though internally differentiated and in due season flowering like other cormophytes. The real difficulty lies in the fact that a more important difference exists between thallophytes and cormophytes, so that when properly defined these groups include respectively plants with the body undifferentiated morphologically; and plants with the body differentiated into root and shoot, the latter usually further differentiated into stem and leaf. These characters at once mark the mosses and liverworts as being neither thallophytes nor cormophytes, for although they possess what may be called stem and leaf they lack a morphological root. This is intensified by the universally understood circumstance that it is the sexual or gametophytic generation

in the mossworts that possesses stem and leaf, the non-sexual or sporophytic generation being undifferentiated, so that no real homologies are to be traced between the shoot of a mosswort and the shoot of a fernwort or seed plant. Hence it comes that careful botanists do not fall into the popular error of treating the mossworts as cormophytes because mosses and liverworts have what we usually speak of as stem and leaf, though the fact may be obscured, perhaps even when stated, that greater morphological reasons dictate the entire abandonment of the old and in a way convenient but now meaningless division of the Vegetable Kingdom into flowerless and flowering plants, in the former of which the heterogeneous assemblage called thallophytes and the well-defined taxonomic groups bryophytes and pteridophytes stand as coördinated. Even though we abandon thallophyte and cormophyte as of serious taxonomic use just as the subdivision of the former into fungi, algæ, and lichens is recognized as more suited to popular than to scientific diction, the essential fact remains that these two words, properly defined, stand for realities in morphology, which, supplemented by a comparable designation for the mossworts (which now bear only the group name bryophytes, comparable with pteridophytes and anthophytes or spermatophytes), divide the Vegetable Kingdom into three main divisions: THALLOPHYTES, with the body undifferentiated into morphological root, stem, and leaf; CORMOPHYTASTERS or pseudocormophytes, with differentiation of the sexual generation into cormoid and phylloid,—the so-called stem and leaf; and CORMOPHYTES, with differentiation of the non-sexual generation into root and shoot, and of the latter, usually, into true stem and leaf.

Recognition that with these gross characters are associated numerous structural details (*e. g.,* the absence of a specialized differentiation between sexual and non-sexual generation even in those thallophytes which by their nuclear behavior show an alternation of generations; the presence—as in many algæ—of pyrenoids and of large chromoplasts in the sexual generation of the liverwort *Anthoceros,* and of stomata—as in mosses and cormophytes—on its unusually evolved non-sexual generation; the appearance of a rudimentary conducting strand in the non-sexual generation of this liverwort and of mosses; the universal development of stomata and

of vascular tissue in the cormophytes) indicates the significance for phylogeny and morphology of the emphasis that is here laid on the coördination of thallophyte, cormophytaster and cormophyte in botanical terminology.

The second term proposed refers to what is commonly called the endosperm of angiospermous plants, sometimes spoken of as secondary endosperm. Very probably descriptive botanists will continue for a long time to speak of seeds as being albuminous or exalbuminous according as they possess or lack a food-reserve in the seed, which is used by the embryo in the early stages of germination. They have not been deterred greatly by the difficulty that sometimes exsits in determining quickly whether or not this reserve tissue is really absent or merely reduced to so thin a layer as to be overlooked—though they try to indicate this difference; nor, for practical reasons, by the now very old knowledge that the ambiguity of the word albumen might make the employment of endosperm and perisperm in its place preferable in descriptive botany. Morphologists, however, have adopted the latter terminology of necessity, as indicating respectively food-reserve within or exterior to the embryo-sac or megalospore (as, of course, the name substituted for the inaccurate "macrospore" should have been coined),—"exalbuminous" seeds being those in which what would have remained as "albumen" has been used up during the maturing of the seed.

Quite as great mischief has been wrought here as with the terms thallophyte and cormophyte, by indiscriminate adoption of this betterment. Although the endosperm of a gymnosperm may be homologised with the endosperm of an angiosperm on the apparent but inapplicable ground that both are transient tissues formed within the embryo-sac, it is well known to every botanist that the gymnospermous endosperm—represented in angiosperms by antipodal cells and synergids—is really homologous with the sexual generation of bryophytes and pteridophytes; while the angiospermous endosperm, or secondary endosperm, originates from the "endosperm nucleus," —after a process which can be called scarcely anything but fertilization except through an over refinement of definition.

If no other considerations were involved, the simplest way might be to speak of the gymnospermous endosperm and its homologue in

angiosperms as prothallus, at once indicating its equivalence with the structure known by this name in the higher cryptogams and facilitating remembrance of the close parallel between pteridophytes and spermatophytes in their alternation of generations; and to continue to speak of the angiospermous endosperm as "albumen." But quite apart from the undesirability of perpetuating the latter word except in the most general taxonomic usage, there is a deep-lying morphological reason for giving a special designation to this "endosperm" of the highest plants.

From the point among thallophytes where an alternation of generations is first recognizable either in somatic or nuclear differentiation, that part of a life cycle which produces egg or sperm, or which has the haploid or as Lotsy has called it the *x* chromosome number, is spoken of as the gametophyte or sexual generation; and that part which produces neither egg nor sperm but begins with them, and which has the diploid or *2x* chromosome number, is spoken of as the sporophyte or non-sexual generation. To be sure not all cells that are not haploid are diploid, for transient fusions of more than two nuclei are known, and the beginnings of the endosperm in a number of aberrant angiosperms start with a blended endosperm nucleus comprising several haploid nuclei; but it is characteristic of the reserve tissue in question that its origin is not in a reduction of chromosomes giving a haploid tissue (as in the gametophyte), or solely in a fusion of contiguous nuclei giving *2x* (as usually in the sporophyte), or *nx* chromosomes (as in rare and exceptional tissues and in aberrant angiospermous endosperm), but that it is a structure distinctly not forming a part of either gametophyte or sporophyte. Its origin is found in a union involving the *2x* or exceptionally *nx* "endosperm-nucleus" (itself derived from a union of the polar nuclei of a typical eight-nucleated embryo-sac, or from the fusion of several nuclei when this number has been increased), and a second nucleus of the pollen as yet indistinguishable from its sperm companion which unites with the egg to form the embryo or initial of the sporophyte; and this union differs from fertilization in the usual sense only in that one of the combining nuclei has already fused with one or more others so as to have more than haploid chromosomes.

This unit in angiosperms, neither sporophyte nor gametophyte, gives a first manifestation of crossing in cases where this can be recognized in the forming seed, *e. g.*, when sugary and starchy corn or kinds with colored and colorless endosperm are crossed, where the phenomenon has been called aptly xenia. The transient generation itself, but not necessarily accompanying hybridity, contrasted morphologically with sporophyte and gametophyte though neither, may be designated with convenience and propriety as the XENIOPHYTE.

The significance of this overlooked generation, confined to the most recent and highest of all plants, the angiosperms, not hinted at elsewhere in the Vegetable Kingdom, and originating from the gametophyte in as distinct specialization of gametoid initials as egg and sperm, is likely to claim serious attention as speculative reasons for evolutionary success and failure come more to the foreground, even though the xeniophyte appears to have reached its term with no more specialized development than the production of a sort of cambium zone and without having achieved the independence possessed by gametophyte and sporophyte—to the latter of which in its most evolved form the xeniophyte now serves as transient host.

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